Assignment 1 : Q1: Report

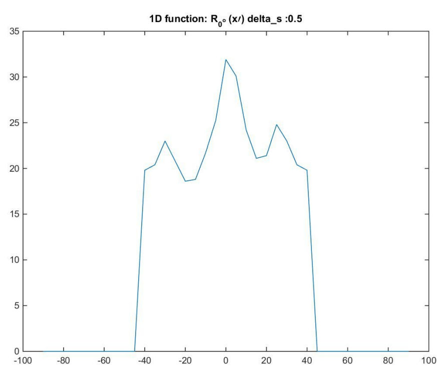
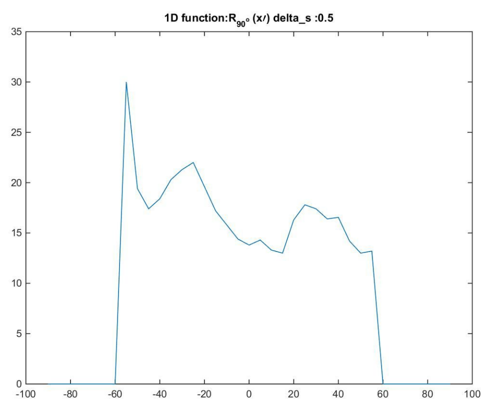
Question 1 X-Ray Computed Tomography: Radon Transform

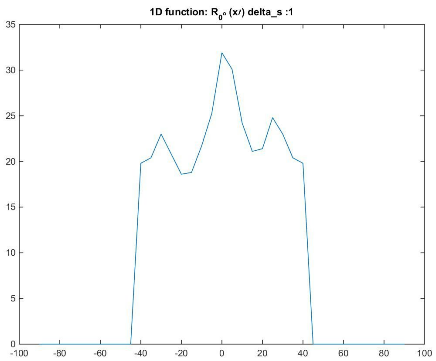
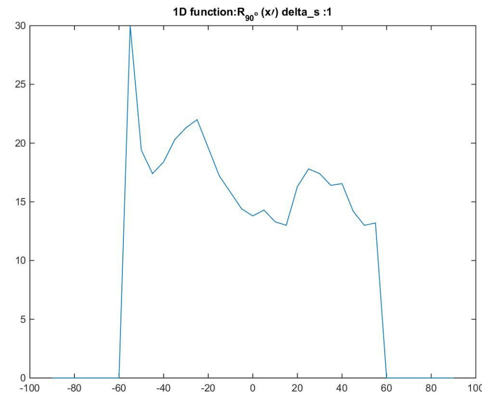
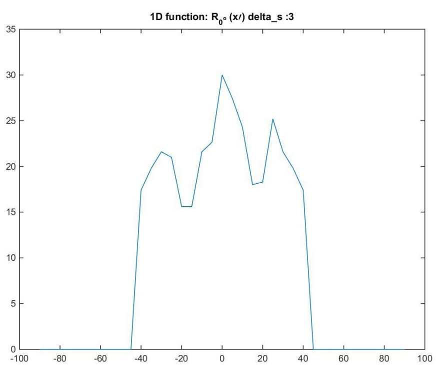
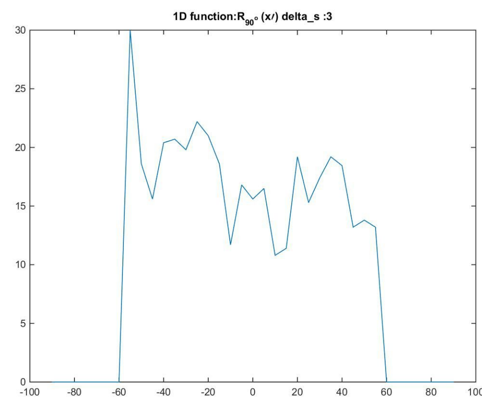
Part a

“myIntegration” function was implemented. We can choose Δ_s to be conveniently 1. Choosing too large step size will result in loss of resolution, on the contrary making Δ_s too smal involves lot of computation and interpolation overhead. So Δ_s=1 seems to manage trade off between two. Interpolation scheme is chosen to be “Bilinear Interpolation”. It is obvious that choosing complex interpolation scheme like “cubic” give us smoother function but it does not preserve range of original data in output and likely to give negative attenuation coefficient values at some positions in image which is unnatural. So bilinear because of range preservation property does best job.

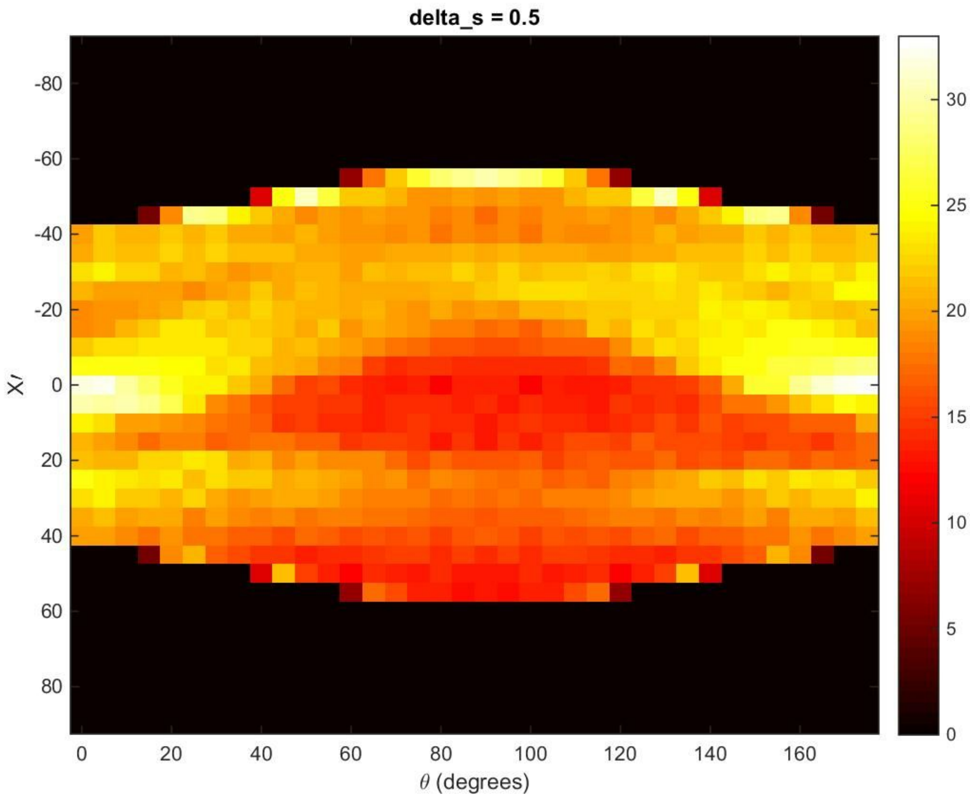
Part b and c

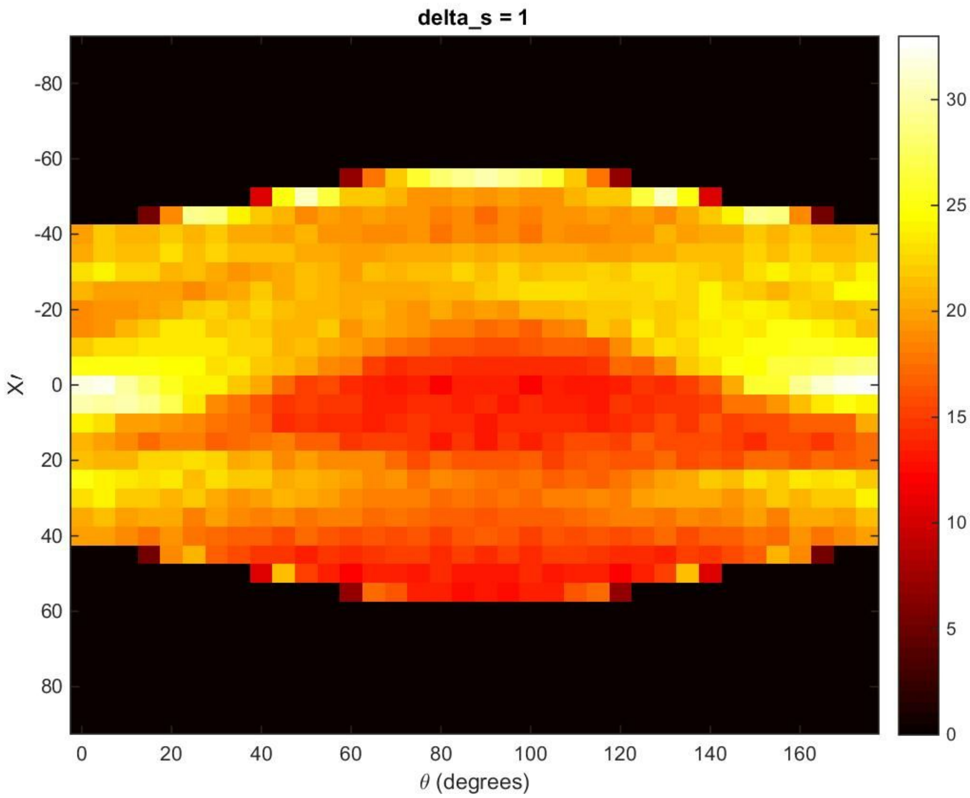
“myRadonTrans” function is implemented and following are output images for different step size Below mentioned table’s rows correspond to different step sizes while column corresponds to angle. High resolution images of the same can be found in “../images/” folder for question 1

	$\theta = 0$	$\theta = 90$
Δ_s =0.5		

<table>
<tr>
<td>Δ_s =1</td>
<td>
</td>
<td>
</td>
</tr>
<tr>
<td>Δ_s =3</td>
<td>
</td>
<td>
</td>
</tr>
</table>

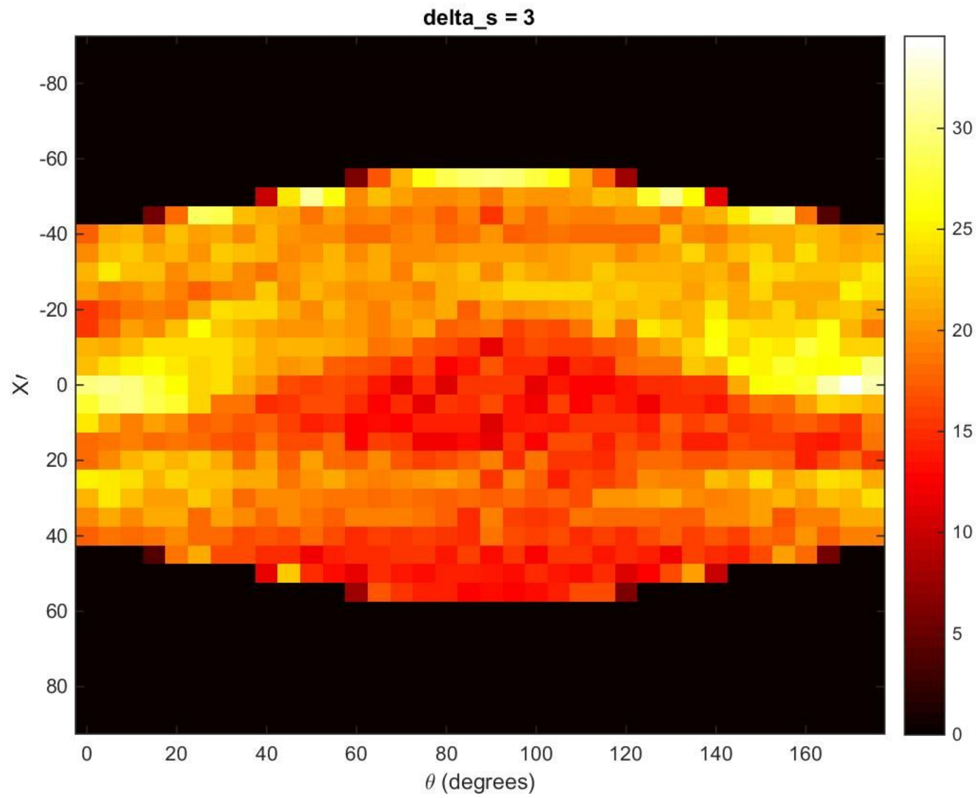
Radon Transform Images are as follows while high resolution images can be located in "..\images\" folder for question 1.
Rows of the table corresponds to different step sizes.

Δ_s =0.5	delta_s = 0.5 X′ -80 -60 -40 -20 0 20 40 60 80 0 20 40 60 80 100 120 140 160 θ (degrees) 30 25 20 15 10 5 0

Δ_s =1	

delta_s = 1
-80
-60
-40
-20
0
20
40
60
80
X′
0
20
40
60
80
100
120
140
160
θ (degrees)
30
25
20
15
10
5
0

Δ_s =3



Δ_s =1 and Δ_s =0.5 1-D plot were roughly the same. Δ_s =3 1-D plot is rougher than others. Exactly same trend is observed in Radon Transform images Δ_s =3 being the roughest. This happens because Δ_s =3 result in coarser quantisation of image result in quantisation noise, same is reflected in roughness of 1-D plot and Radon transform image.

Δ_s relates to quantization noise. The image itself is quantized (digital pixel). We can't improve quantization noise beyond certain limit even after lowering delta by whatever amount. Specifically for all Δ_s less than 1 pixel, we should get same noise, because image itself is quantized with 1 pixel length. (exact limiting value of Δ_s might depend upon theta of integration, but 1 pixel seems to be the lower bound in those values)

Part d

Δ_{theta} and Δ_t will determine x-y resolution the of radon transform. If we analyse carefully, the radon transform is nothing but another way to acquire fourier transform. So increasing Δ_t and Δ_{theta} correspond to sampling fourier transform at lower resolution so it will introduce artifacts like aliasing in reconstructed image. If we increase the resolution then there is nothing wrong in that it is just that patient is exposed to radiation for longer duration which is not advisable. So choice of these parameters depend on the resolution you want in reconstructed image, you are fine with low resolution then sampling fourier transform at lower resolution suffice. So this choice of parameters depend on the requirement of resolution in reconstructed image.

Part e

$\Delta_s << 1$ then interpolation overhead will be too much and hence computationally infeasible on the contrary $\Delta_s >> 1$ will lead to loss of resolution in reconstructed image and hence results in noisy radon transform as well. Anyways for $\Delta_s < 1$ we are not going to observe much of the improvement due the reasoning explained in part c. So we don't gain anything significant by lowering $\Delta_s << 1$ below 1 pixel while we will be spending the cost for computation in those cases.